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Lin

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(54) **LENS MODULE**

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G02B 6/36	(2006.01)
G02B 6/42	(2006.01)

(52) **U.S. Cl.**

CPC ***G02B 6/4292*** (2013.01); ***G02B 6/4214*** (2013.01); ***G02B 6/4231*** (2013.01); *G02B 6/322* (2013.01)

(58) **Field of Classification Search**

CPC ... G02B 6/4214; G02B 6/4231; G02B 6/4292
USPC 385/33, 93
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,335,411	B2 *	12/2012	Kuznia et al.	385/33
2012/0008901	A1 *	1/2012	Yu et al.	385/74
2014/0099057	A1 *	4/2014	Sun et al.	385/33

* cited by examiner

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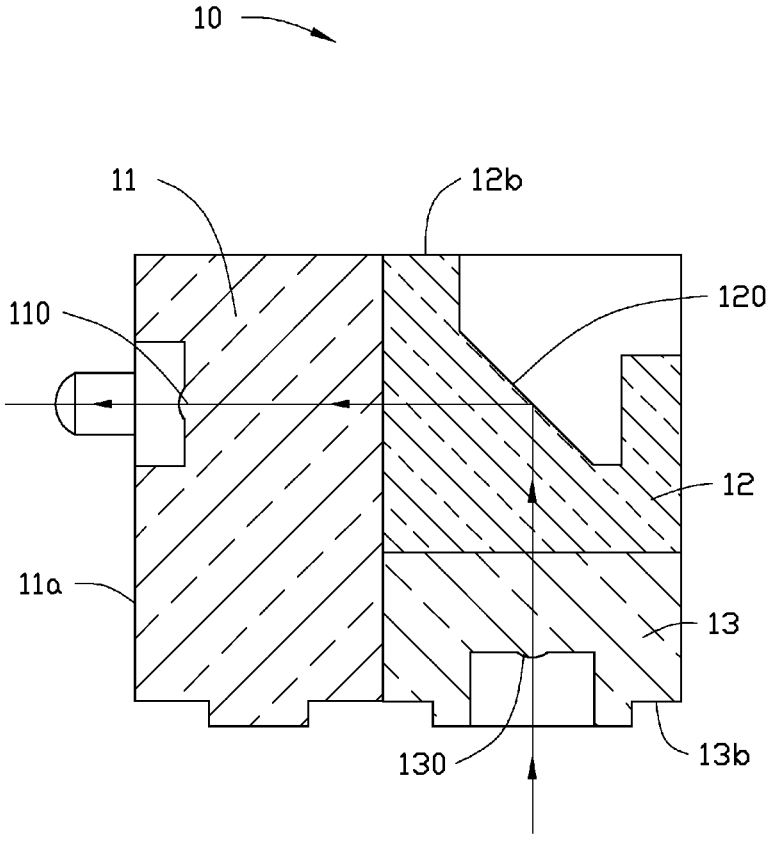
(57) **ABSTRACT**

A lens module includes a front lens unit and a bottom lens unit. The front lens unit includes a number of first lenses having parallel optical axes. The bottom lens unit is detachably connected to the front lens unit. The bottom lens unit includes a number of second lenses having parallel optical axes.

3 Claims, 7 Drawing Sheets



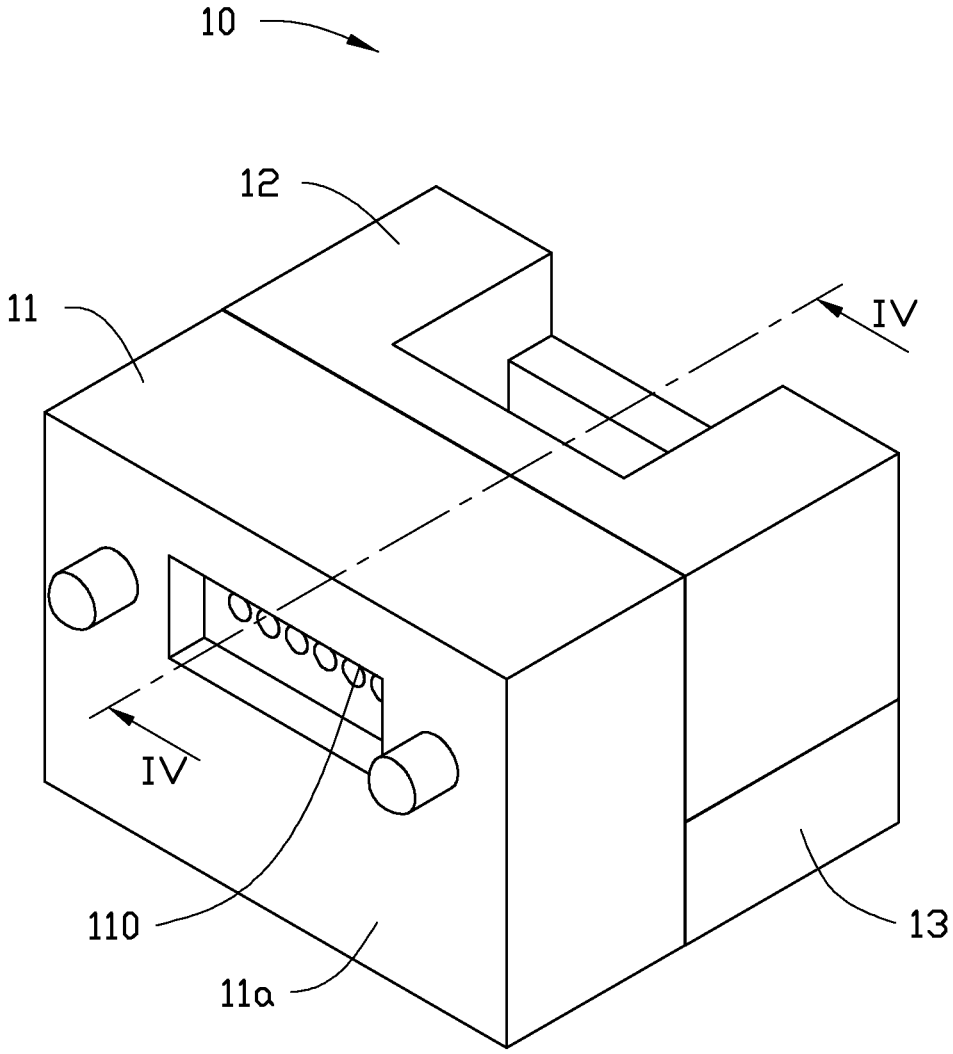


FIG. 1

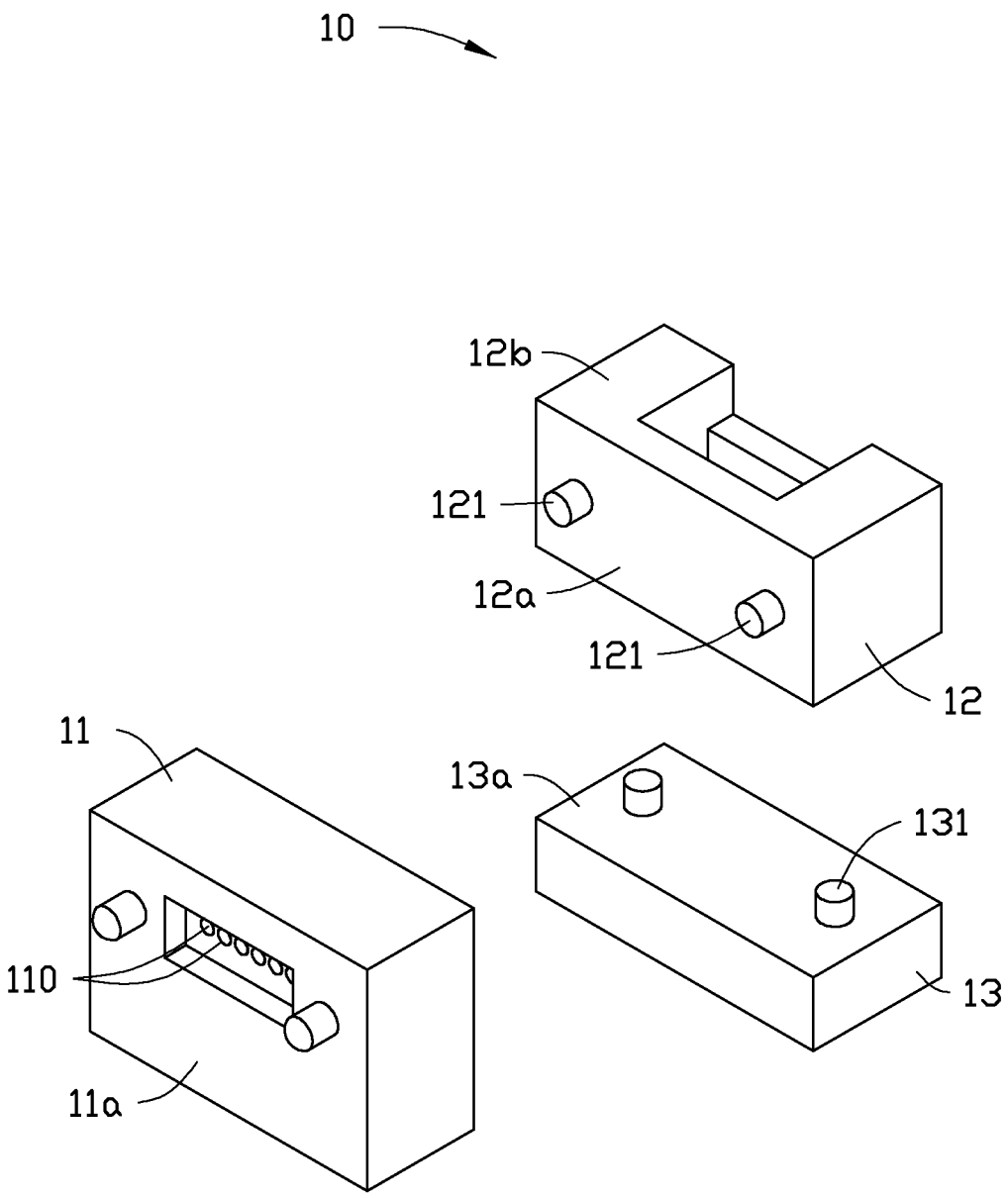


FIG. 2

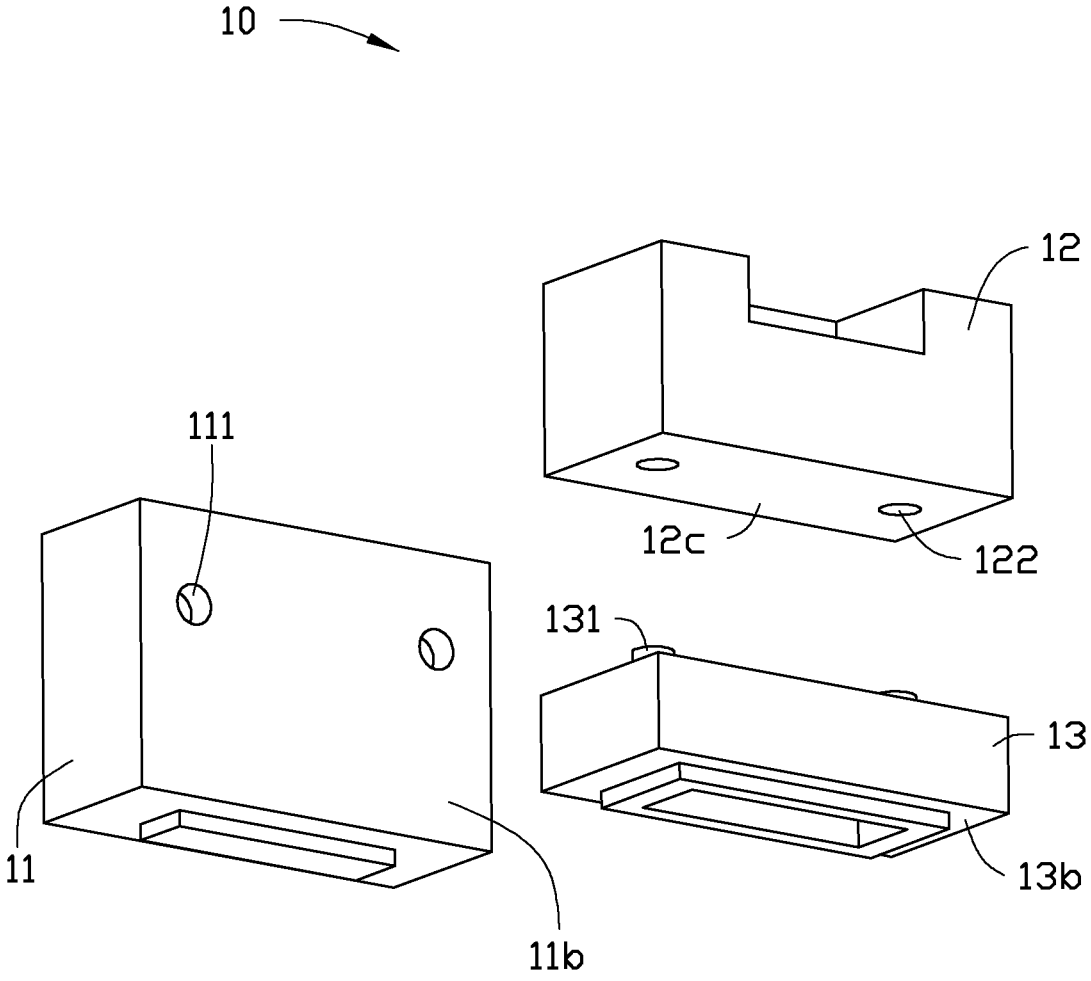


FIG. 3

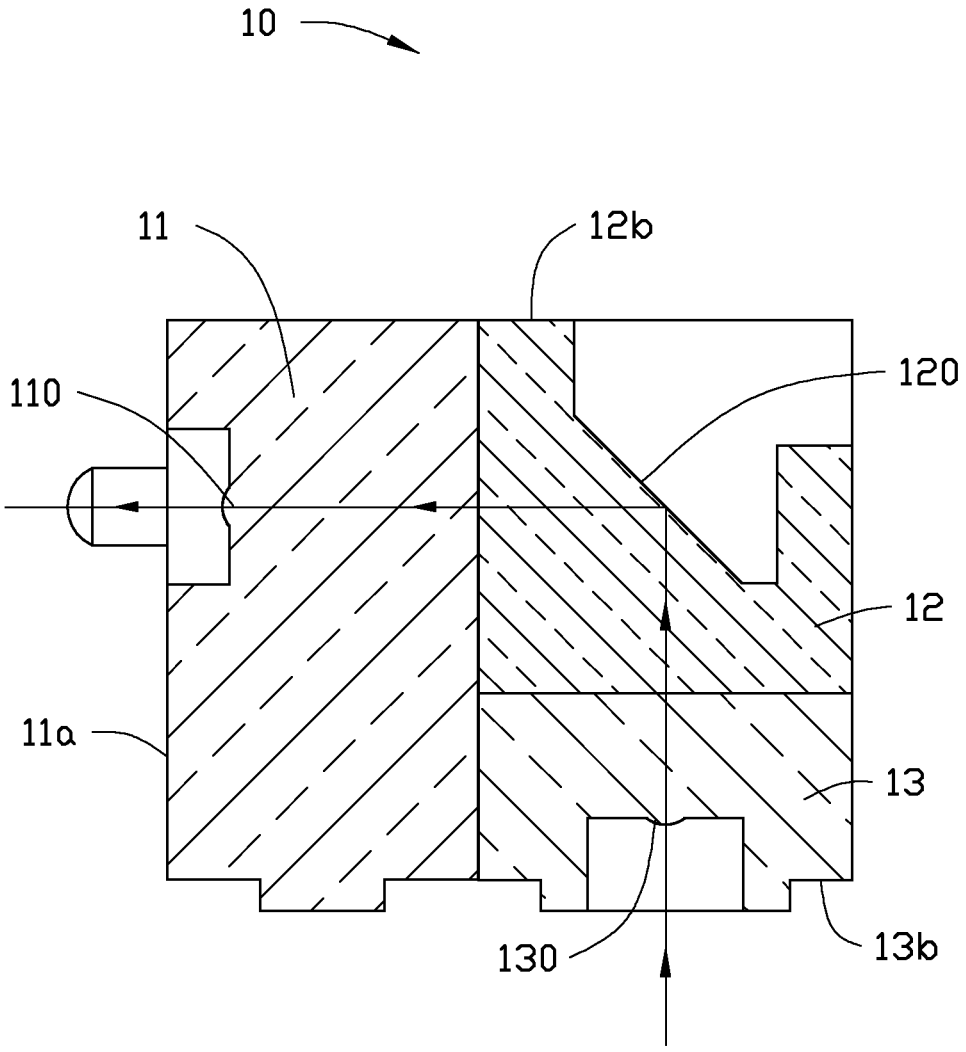


FIG. 4

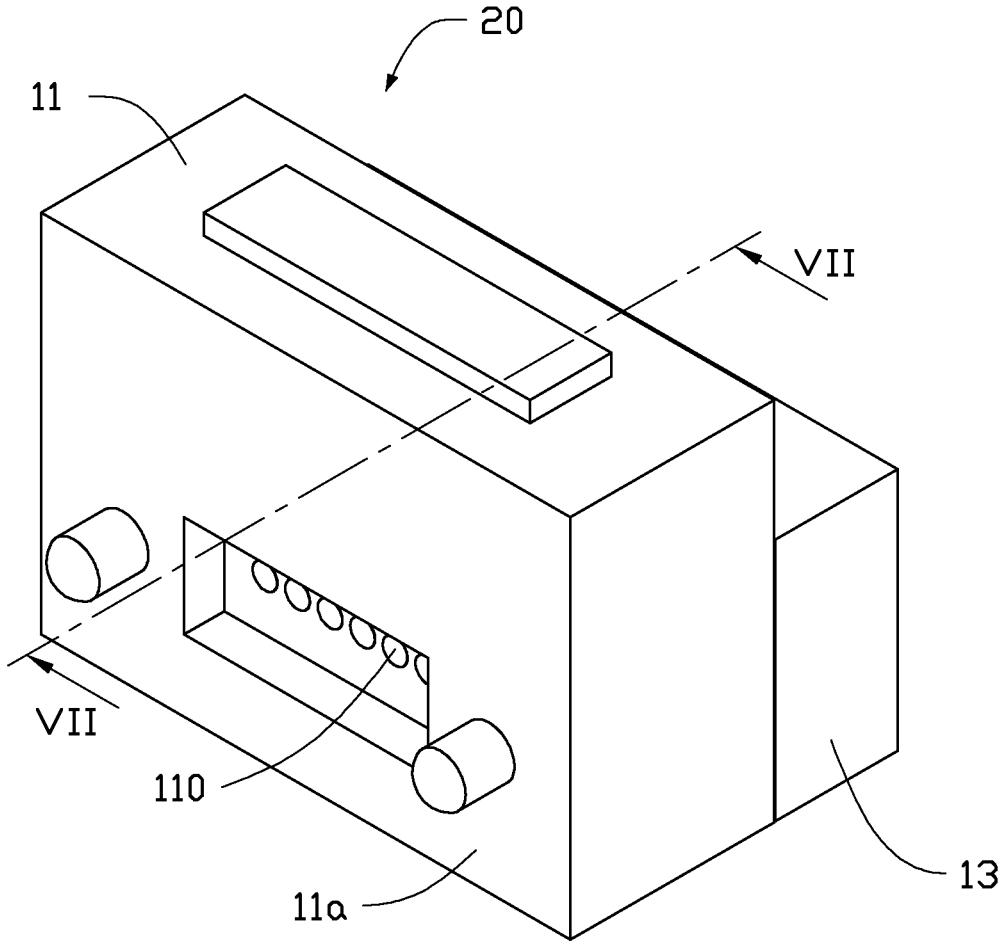


FIG. 5

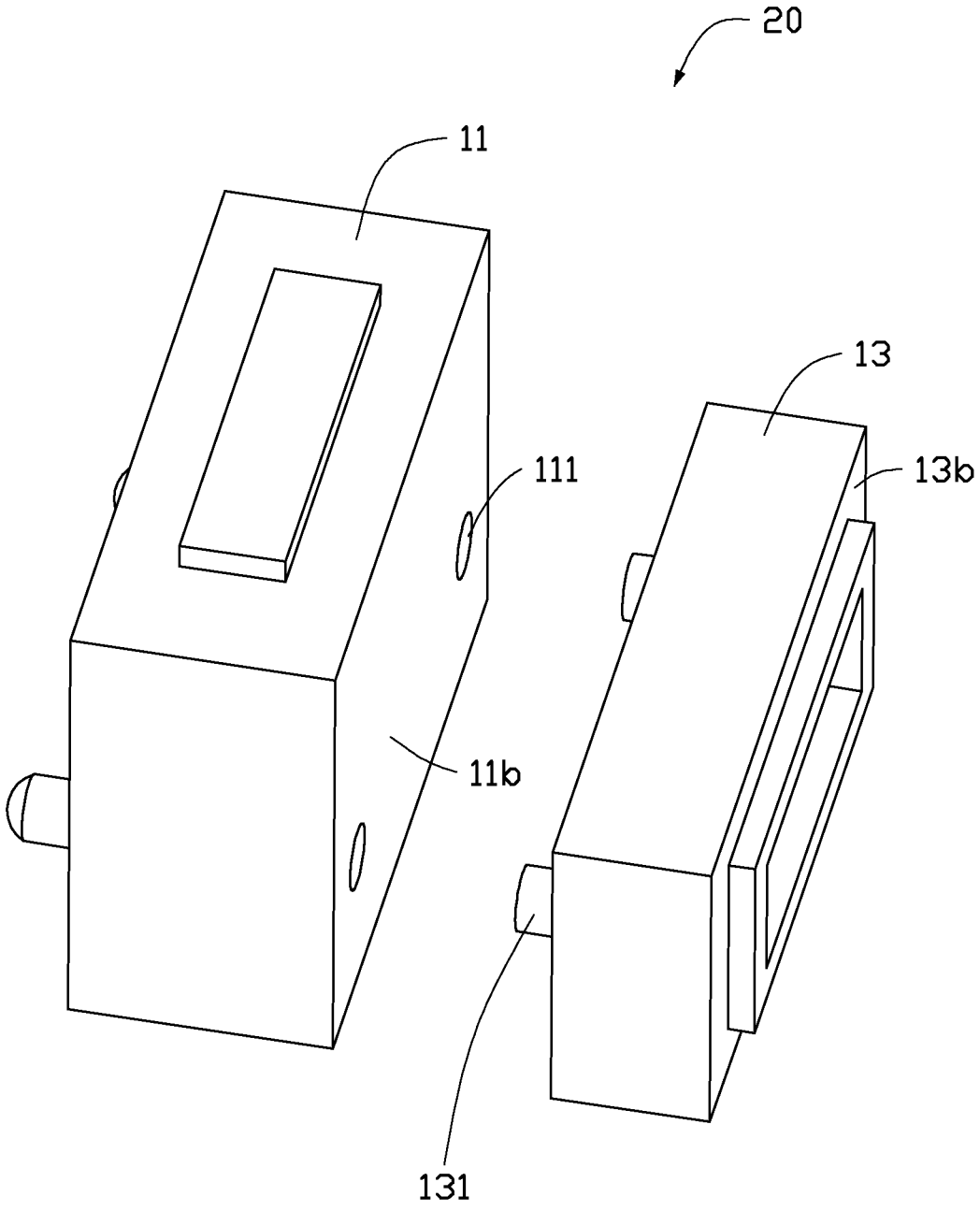


FIG. 6

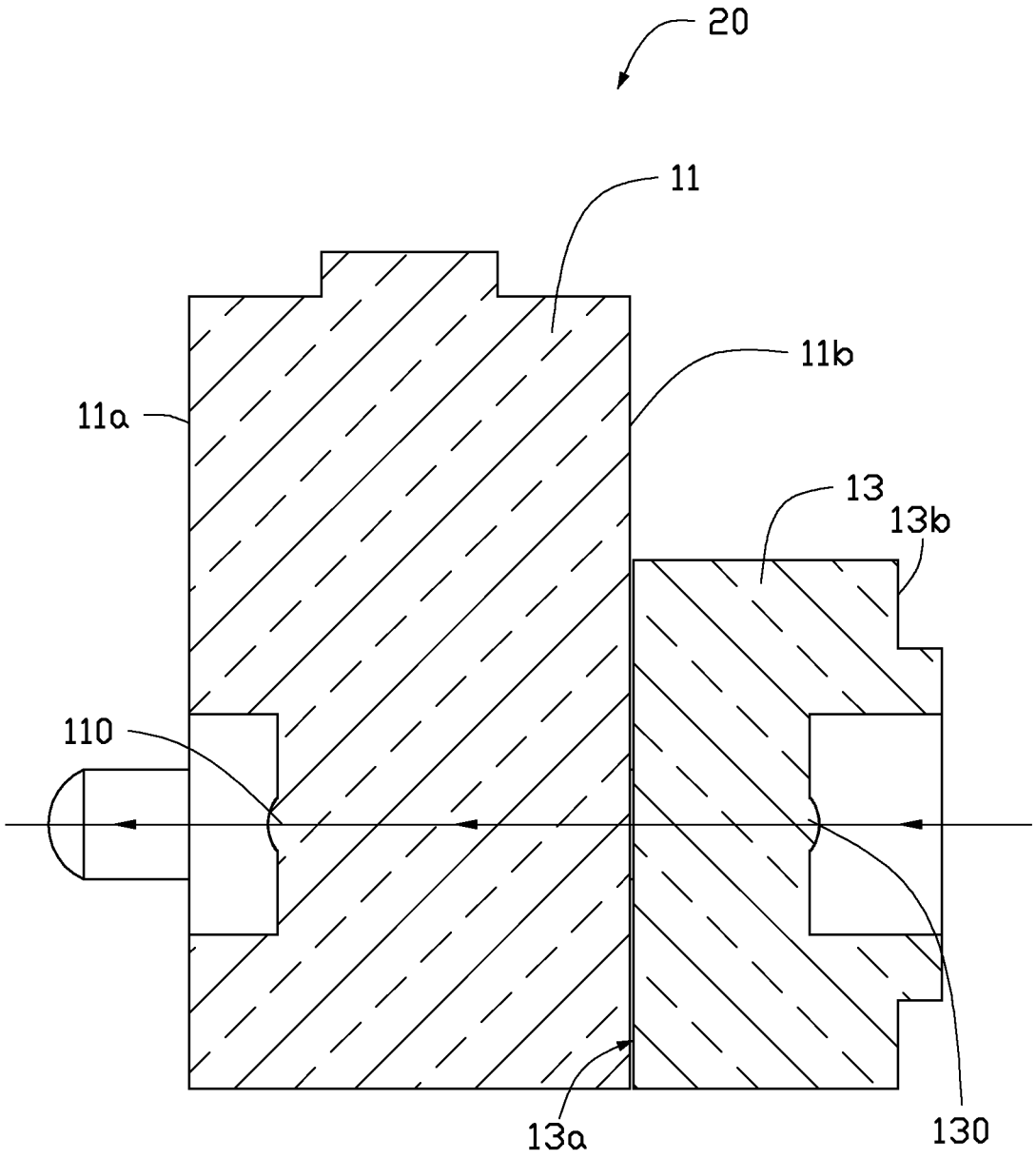


FIG. 7

LENS MODULE

BACKGROUND

1. Technical Field

The present disclosure relates to a lens module.

2. Description of Related Art

Lens modules are used in optical-electric convertors. The lens module can be either a refractive-type lens module or a direct-type lens module. In refractive-type lens modules, light is bent 90 degrees. In direct type lens modules, the light directly passes through.

Refractive-type lens modules achieve a small size, but are difficult to manufacture. The direct-type lens modules are easily manufactured, but are bigger than the refractive-type lens modules.

Therefore, it is desirable to provide a lens module that can overcome the limitations described.

BRIEF DESCRIPTION OF THE DRAWINGS

The components of the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the embodiments of the present disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout several views.

FIG. **1** is an assembled schematic view of a lens module, according to an exemplary embodiment.

FIG. **2** is an explosive view of FIG. **1**.

FIG. **3** is another explosive view of FIG. **1**.

FIG. **4** is a cross-sectional view taken along line IV-IV of FIG. **1**.

FIG. **5** an assembled schematic view of a lens module, according to another exemplary embodiment.

FIG. **6** is an exploded view of FIG. **5**.

FIG. **7** is a cross-sectional view taken along line VII-VII of FIG. **5**.

DETAILED DESCRIPTION

Referring to FIGS. **1** to **4**, a lens module **10**, according to an exemplary embodiment, is shown. The lens module **10** includes a front lens unit **11**, a reflective unit **12**, and a bottom lens unit **13**. The front lens unit **11**, the reflective unit **12**, and the bottom lens unit **13** are detachably connected to each other.

The front lens unit **11** is configured for coupling to optical fibers, the reflective unit **12** is configured for reflecting light, and the bottom lens unit **13** is configured for coupling to electric-optical elements (not shown). The electric-optical elements include light-emitting elements and light receiving elements.

The front lens unit **11** includes a first surface **11***a* and a second surface **11***b* opposite to the first surface **11***a*. A plurality of first lenses **110** is arranged on the first surface **11***a*, and two front locating elements **111** are located on the second surface **11***b*. Each of the first lenses **110** is coupled to one optical fiber. The optical axes of the first lenses **110** are parallel to each other. The front locating elements **111** attach the front lens unit **11** to the reflective unit **12**. In this embodiment, the front locating elements **111** are holes. In other embodiments, the front locating elements **111** can be posts.

The reflective unit **12** includes a third surface **12***a*, a fourth surface **12***b*, and a fifth surface **12***c*. The third surface **12***a* is perpendicular to the fourth surface **12***b*. The third surface **12***a* is also perpendicular to the fifth surface **12***c*. The fourth surface **12***b* is parallel to the fifth surface **12***c*. A reflecting surface **120** obliquely extends from the fourth surface **12***b* towards the fifth surface **12***c*. An angle between the reflecting surface **120** and the fourth surface **12***b* is about 45 degrees. Two first locating elements **121** are located on the third surface **12***a*, and two second locating elements **122** are located on the fifth surface **12***c*. The first locating elements **121** are posts, and are received by the front locating elements **111**. The second locating elements **122** attach the reflective unit **12** to the bottom lens unit **13**. In other embodiments, the first locating elements **121** can be holes. The second locating elements **122** are holes, but can be posts in other embodiments.

The bottom lens unit **13** includes a sixth surface **13***a* and a seventh surface **13***b* opposite to the sixth surface **13***a*. Two bottom locating elements **131** are located on the sixth surface **13***a*. The bottom locating elements **131** are posts, and are received by the second locating elements **122** to attach the reflective unit **12** to the bottom lens unit **13**. A plurality of second lenses **130** is arranged on the seventh surface **13***b*. The optical axes of the second lenses **130** are all parallel to each other. A number of the second lenses **130** is equal to a number of the first lenses **110**. The alignment of the second lenses **130** is the same as the alignment of the first lenses **110**. The optical axes of the first lenses **111** is perpendicular to the optical axes of the second lenses **130**. The bottom locating elements **131** are posts, but can be holes in other embodiments.

Light emitted from the light-emitting elements shine into the bottom lens unit **13** through the second lenses **130**. The light passes through the bottom lens unit **13** and shines onto the reflecting surface **120** of the reflective unit **12**. The light is bent 90 degrees by the reflecting surface **120**, and then enters into the front lens unit **11**. Finally, the light exits from the first lenses **110** of the front lens unit **11**.

Light entering from the first lenses **110** shines into the front lens unit **11**, and is reflected by the reflecting surface **120** of the reflective unit **12**. The reflected light enters into the bottom lens unit **13**. The light receiving elements receive the light exiting from the second lenses **130** of the bottom lens unit **13**. The reflecting surface **120** bends the light 90 degrees.

Referring to FIGS. **5-7**, another lens module **20**, according to another exemplary embodiment, is shown. The lens module **20** includes the front lens unit **11** and the bottom lens unit **13**. The lens module **20** is a direct type lens.

The front locating elements **111** of the front lens unit **11** receive the bottom locating elements **131** of the bottom lens unit **13**, to attach the front lens unit **11** to the bottom lens unit **13**. Light emitted from the light-emitting elements passes through the second lenses **130** of the bottom lens unit **13** and exits from the first lenses **110** of the front lens unit **11**. Light entering through the first lenses **110** of the front lens unit **11** passes through the bottom lens unit **13** and then exits from the second lenses **130**. The light receiving elements receive the light exiting from the second lenses **130** of the bottom lens unit **13**. For the above description, the direction of the light is not changed.

The front lens unit **11**, the reflective unit **12**, and the bottom lens unit **13** are separately made, and are easily assembled together, so a manufacturing process of the lens modules is simplified.

It is believed that the present embodiments and their advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the disclosure or sacrificing all of its material advantages, the examples hereinbefore described merely being preferred or exemplary embodiments of the disclosure.

What is claimed is:

1. A lens module, comprising:

a front lens unit comprising a plurality of first lenses, the first lenses having parallel optical axes;

a bottom lens unit detachably and directly connected to the front lens unit, the bottom lens unit comprising a plurality of second lenses, the second lenses having parallel optical axes, bottom surfaces of the front lens unit and the bottom lens unit coplanar to each other; and

a reflective unit detachably connected to the front lens unit and the bottom lens unit, the reflective unit comprising a reflecting surface, the optical axes of the first lenses and the optical axes of the second lenses intersecting on the reflecting surface.

2. The lens module of claim **1**, wherein the front lens unit comprises a front locating element, the bottom lens unit comprises a bottom locating element, the reflective unit comprises a first locating element and a second locating element, the first locating element is engaged with the front locating element to secure the front lens unit to the reflective unit, and the second locating element is engaged with the bottom locating element to secure the reflective unit to the bottom lens unit.

3. The lens module of claim **2**, wherein both the front locating element and the second locating element are holes, both the first locating element and the bottom locating element are posts.

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